PUBLIC SAFETY LTE PRIORITIZATION AND PREEMPTION QUALITY OF SERVICE

MOTOROLA SOLUTIONS

PUBLIC SAFETY: TRANSFORMED

We are now on the cusp of a new era of innovation in public safety. The rollout of Public Safety LTE (PS LTE) networks means that your personnel will be able to access dedicated and secure high-speed data services. These standards-based networks are attracting a wide range of developers to create new applications and provide services that will transform your agency.

From enriched location applications, to accessing building plans on the run, to improved tactical collaboration applications, to sensors and real-time high-definition video streaming, your agency and your first responders will be better equipped to predict, prepare for and respond to situations with PS LTE. This is especially true of streaming high definition video that will give dispatchers, supervisors and those on the ground invaluable "eyes" on unfolding situations. Indeed, through PS LTE, your personnel's ability to work more efficiently while safeguarding themselves, colleagues, and the public will advance significantly.

WHAT ARE PRIORITIZATION AND PREEMPTION?

Prioritization sometimes is confused as a form of preemption. While they combine to work together to manage traffic on the network, there is a real difference between the two. One easy way to think about this is to imagine people waiting in line for the next customer service window. As new people join the line, prioritization reshuffles the line from high to low so that the highest priority customers are always at the front of the line. Preemption, also known as "ruthless" preemption, goes a step further and removes the lowest prioritized customer already at the service window so that the higher priority customer can begin their transaction immediately.

DEDICATED DOES NOT MEAN STANDALONE

PS LTE is often thought about as a dedicated network connecting responders, the equipment they carry and their vehicles to other responders and to headquarters, but that's just one aspect in play. It's important to understand that information critical to successfully delivering public safety services will be delivered over PS LTE from many areas including: citizens, government and commercial facilities, utilities, transportation and the internet of things (IoT). An increasingly connected world also means an ever more complex information environment and an ever growing load on the PS LTE system. That load can negatively impact quality of service (QoS) and impair efficiency and safety. This paper will discuss how PS LTE prioritization and preemption ensure that the right information is always available at the right time.

TAKING THE BEST OF LAND MOBILE RADIO FOR PUBLIC SAFETY LTE

As we plan for a future with PS LTE we need to look at why today's public safety networks have become so valuable to first responders. The success of Project 25 (P25), and TETRA Land Mobile Radio (LMR) is based around the fact that the systems and devices are designed for the unique needs of public safety. In addition to being used by first responders, LMR has also been adopted by enterprises that require the same level of mission critical reliability from their devices, infrastructure, and systems. Indeed, users around the world trust that, whatever crisis awaits them, the lifeline of LMR communications will work – always. And critically, in the over 80 years that LMR has been used in public safety, the system's capabilities have been continually fine-tuned to user's needs to ensure they get the right quality of service at the right time. The lessons learned from LMR will benefit PS LTE as it continues to mature and add new capabilities into the future.

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To be clear, the first iterations of PS LTE will handle data and voice carried by over the top (OTT) applications instead of being carried natively. That's one reason why LMR mission critical voice and PS LTE high speed data will be used together as complementary technologies. Additionally, because the systems ensuring that calls always get through - called priority and preemption - are so refined on LMR systems, users may not even be aware of the technology that is working hard behind the scenes to protect them. The same tools are not as mature on LTE, if they are available at all. While standard LTE can have some basic prioritization and preemption capabilities and some commercial carriers for an extra fee may offer to segment your traffic, these options are nowhere near the granularity needed to meet the operational expectations of your dispatchers, commanders, users, or the communities you serve. To meet the need, there are priority and quality of service (QoS) preemption systems available that when added to LTE can deliver the mission critical capabilities expected by public safety.

WHEN EVERYTHING IS AN EMERGENCY NOTHING IS

It isn't enough to only prioritize devices or users. If every public safety agency in a jurisdiction has a higher priority level assigned to their devices, really nothing is prioritized. They may have priority over other devices on the network, but they'll compete equally with each other for network resources. Effective command and control requires that key information is always able to get though, no matter how busy the network is and that may require prioritizing traffic ahead of others or even prempting sessions already in progress. That isn't possible on a network where everything is treated equally.

THE NEED FOR DEDICATED NETWORK CONTROL

There is an ongoing debate across countries worldwide about how and if spectrum can be allocated to balance the needs of commercial and PS LTE users. In some situations, the only option available will be to use the existing public carrier system. Whatever the outcome of these discussions, agencies must be aware that communications cannot be guaranteed over commercial networks. Even with the benefit of dedicated spectrum or robust network capacity, prioritization and preemption QoS are essential to ensuring the flow of information critical to delivering public safety services, making better decisions and improving responder safety. The biggest concern here, which has been proven time and again, is that in major incidents or even something as routine as a sporting event, systems can become oversaturated **(see table 1)**. So much so that it leaves first responders without network access. Even with day-to-day operations, there are no guarantees that your people will be given service priority on a commercial carrier's system. The reason for this is that the LTE standard has limited provision for prioritization, with options only based around the users' device **(see figure 1)**. This this type of prioritization doesn't allow the degree of tailoring that's needed by public safety, including settings for individual users, devices, applications and type of incident.

Ideally, you want to provide services over private LTE coverage designed to your mission critical standards that you own and control

but it's recognized that there will be situations where a mixed model of private and commercial or all commercial carrier implementations will be necessary. In any of these configurations, use of a purpose built prioritization and preemption solution, configured by your agency, to your unique needs, while being invisible and seamless to end users, is critical to better decisions and improved safety. It's also important to point out that much of today's thinking about the need for prioritization and preemption focuses on large systems of fixed infrastructure. The future will add new layers of PS LTE portable infrastructure to the operational model. From trailored, vehicular and aerial platforms to body worn and tactical cases, portable infrastructure will increasingly be used around the clock to augment coverage, provide private secure networks or even create a bubble of coverage where there isn't any. In the near term, these smaller systems will not have the capacity levels provided by fixed infrastructure, making the need for prioritization and preemption that much more critical.

With this in mind, we look in the next section at the type of prioritization and control that public safety expects. We move on to detail the questions to ask the organization that will build and run your network — whether they will be public or private providers — to ensure that you can dynamically give your people the right quality of service to help them perform effectively.

PRIORITIZATION AND PREEMPTION REQUIRE GRANULARITY AND CONTROL

You want to ensure that your PS LTE system can sense what's happening on your network every second and control prioritization and preemption based on a range of variables. Additionally, public safety operates in a highly dynamic environment where needs and priorities can change from second to second, so just as important is the need to be able to quickly, manually provide elevated priority with interactive applications and GIS tools.

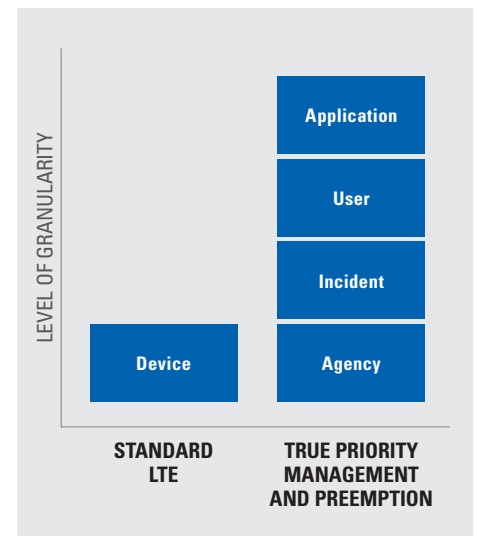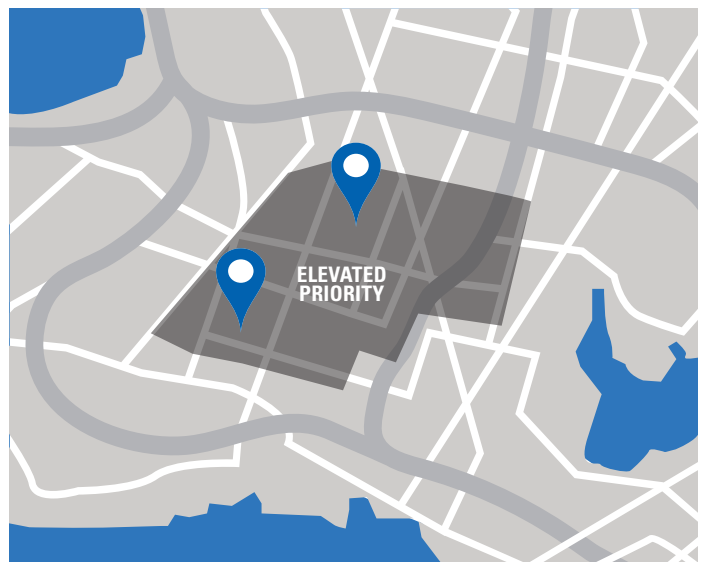| EXAMPLES OF COMMERCIAL LTE FAILURES DURING EMERGENCIES			
EVENT	FAILURE	CAUSE	IMPACT
Seattle Seahawks Superbowl victory parade, February 2014[1]	Text, email, video, pictures and calls, overwhelm carrier networks.	Parade goers cause congestion on networks already beefed up for the event.	Seattle emergency operations notifies users to limit use so 9-1-1 calls can get through.
Boston Marathon bombing, April 2013[2]	Commercial cellular networks overloaded.	Even with capacity added for the marathon, commercial cellular networks were overwhelmed by too many people trying to use voice and data.	People in the area and family and friends trying to contact those in the area, were blocked from using the networks.
Mid-Atlantic earthquake, August 2011[3]	Cell phone calls blocked.	Consumers jammed cell phone networks with voice calls to family and friends.	Service was not restored until hours later when call volume subsided.

Table 1

Figure 1

AUTOMATIC PRIORITIZATION

Set it and forget it. Automatic prioritization and preemption settings tailored to your operations dynamically adjust service based on user's device, role, location and type of operation they face.

MANUAL PRIORITIZATION

You are in control. Quickly make real-time prioritization decisions based on an unfolding situation and easily make temporary adjustments on the fly.

Figure 2

ADAPT.
ADJUST.
ALLOCATE.

REAL-TIME PRIORITY ADAPTS TO THE SITUATION

True prioritization and preemption QoS allows a precise level of control with the smarts to dynamically change as the operational picture changes. With a tailored configuration for a wide spectrum of parameters including: agency, user status, application, incident priority and proximity to key and sensitive geographic areas, systems automatically adjust levels in real-time to meet QoS plans. In addition to these automatic configurations, we discuss below the methods of direct control needed to meet other types of scenarios and deliver the complete set of capabilities needed by public safety.

ELEVATED PRIORITY

ADJUST PRIORITY WITH GEO-FENCING

Automatic configuration plans are an essential foundation for overall control, there will be cases, however, where a specific area(s) needs to be designated with a different priority setting that overrides the plan. Geo-fencing uses boundary areas drawn on an interactive map to set LTE prioritization at a different level than the areas around it. For example, that defined area could be as large as several city blocks, as small as a house, a hospital campus, or even the length and width of a major highway running through a jurisdiction. The PS LTE system then handles the rest automatically; priority is immediately changed for every user, device and application within, entering or leaving the geo-fence.
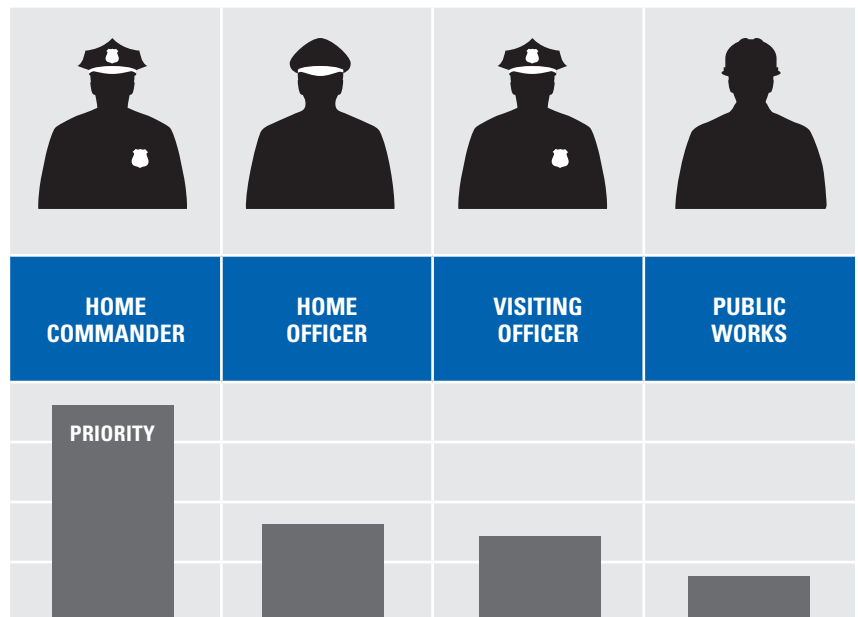
DURATION AND NUMBER	From one to many geo-fences can exist simultaneously and be short-lived, such as an area quickly drawn by an incident commander, or longer-lived for example a week long festival, or perhaps even permanent around high crime or sensitive areas.
TIME AND DAY	Time and day activated geo-fencing automatically alters prioritization on a predetermined schedule for preplanned events including regularly occuring school athletics and other major events.
PREPLANNED	Preplanned geo-fences are created and staged, ready for quick activation for infrequent events, major disasters and evacuations.

ALLOCATE PRIORITY AND PREEMPTION ON THE FLY

Imagine a large scale incident where some responders are on the frontline, others are acting in support roles, extraneous in-vehicle cameras are streaming unuseable video, agencies from other jurisdictions are onscene and secondary responders are arriving. In the event that users or the command post are experiencing degraded performance, the incident commander or their designee can immediately take corrective action to adjust the priority and preemption settings to improve the flow of information for those handling the incident. Pinpoint control takes prioritization to the ultimate levels of granularity. Easy to use apps give incident commanders, dispatchers and other authorized users unprecedented capability to fine tune every aspect of the PS LTE bandwidth continuum while remaining within network QoS parameters. From applications and devices to individual users; on the fly adjustments quickly prioritize and deprioritize traffic and can change preemption authority.

HOME COMMANDER	HOME OFFICER	VISITING OFFICER	PUBLIC WORKS
PRIORITY			

USE CASES

PROACTIVELY ADJUST ROLES FROM PATROL TO SWAT

Your team's role may be fixed or may sometimes change as they go through the day. For example, a specially trained firearms officer working patrol in the morning could be activated as a member of the SWAT team for a hostage crisis in the afternoon.

In this type of fast moving situation, it is essential that as soon as the officer's role changes, their PS LTE access for their devices as well as key applications – such as a tactical assault application – is elevated at the same time. When the incident is over, and their role returns to patrol, the quality of service settings return to normal to preserve bandwidth for other uses **(see figure 3)**.

PROACTIVELY ADJUSTING TO MULTIAGENCY RESPONSE

Similarly, in the case of a rapidly spreading fire you need network performance to adjust for coordination of the multi-agency response. For example, local fire and law enforcement would be given high priority as would mutual-aid teams called from neighboring jurisdictions to give assistance. Command and collaboration data will be shared at the highest service level across the teams so that key information, from video to weather reports, to maps showing the location of homes and positions of responders and apparatus, can be quickly accessed. **(see figure 4)**

MATCH YOUR PRIORITY TO THE SEVERITY OF THE INCIDENT

It's vital to assign prioritization and preemption based on incident type and incident priority information received from the computer aided dispatch system (CAD). For example, a wellbeing check in the same area as other officers who spot a suspect's car would be automatically assigned at a lower level so the traffic stop can be given optimum network service to ensure live footage from vehicle and body cameras **(see figure 5)**. Likewise, when approaching a domestic incident at an address with prior threats against public safety, responders can be allocated a higher level of service. And, if an emergency notification is received, dispatch can manually escalate the quality of service to the highest priority and preempt other non-emergency traffic to ensure that incoming and outgoing data services are received and sent in real-time.

APPLICATIONS AND DEVICE PROFILES

It's important to be able to specify priority for particular applications over others **(see figure 6)**. For example, there may be critical video that must be accessed from an incident, or it could be vital that teams can share collaborate and view a tactical incident application. Clearly, these applications should take precedence over a small scheduled automated software update for the devices within range of the incident. You may also need to give specific devices priority such as those shared by a specific team or used by a specific user type. Also, even with prioritization, it's critical to conserve bandwidth intelligently. Imagine a bank robbery in progress where a large number of squad cars respond. Some of those cars might be parked next to walls and have no sight of the incident so it makes sense to manually throttle or switch off bandwidth to these devices. Instead, bandwidth can be reserved for video streamed from cars and officers whose cameras have a clear sight of the exits and interior.
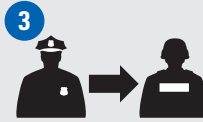
ROLE CHANGE USE CASE

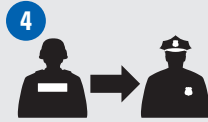**1** Police Officer on patrol with priority level normal

2 Dispatcher activates SWAT team.

3 Officer's role changes to SWAT. Priority manager automatically sets QoS levels to high.

4 Incident resolved and officer returns to patrol duty. Priority Manager automatically returns QoS to normal.

Figure 3

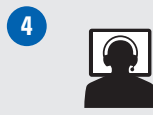## RAPID SPREADING FIRE USE CASE

1 Local fire teams on scene and given high priority.

2 FF Chief requests help from neighboring agencies.

3 Neighbor agency arrives

4 Dispatch dynamically adjusts neighbor agency's QoS

Figure 4

TRAFFIC STOP USE CASE

1 **Officer A** is on location for a well being check and receives a low priority.

2 **Officer B** in the same area pulls over a suspicious vehicle and receives an elevated priority to stream video.

3 **Officer B's** traffic stop is over and his priority returns to normal.

Figure 5

Figure 6

RUTHLESS PREEMPTION ENSURES INFORMATION GETS THROUGH

Preemption overrides network QoS settings and immediately clears the path, even to the point of knocking others off of the system so information gets through. Just as prioritization has different levels, preemption does as well. An incident commander may have preemption authority over other responders to ensure they are able to send and receive information. A declared or suspected imminent emergency such as, "shots fired" would in turn have the absolute highest preemption authority overriding even an incident commander.

PLAN NOW

Every public safety agency we work with is focused on giving its people the best solutions to help them safely complete their missions. The best PS LTE networks include flexible and granular control of prioritization and preemption. In our discussions with agencies we have seen a widespread assumption that the special applications and services that are available on today's LMR networks will be automatically available over PS LTE. However, standard prioritization commercial carrier options if they are even available are limited and will not meet the operational demands of public safety.

This said, versatile prioritization and preemption is achievable with dedicated solutions designed for mission critical operations. With this in mind, these are the questions that we recommend you ask of PS LTE network providers.

EASE OF INTEGRATION

Is the recommended solution compatible with LTE standards allowing for a simple integration with your network?

A COMPLETE VIEW

Can the solution enable a complete view of all devices and users provisioned on your system?

HIGHLY GRANULAR CUSTOMIZATION

Can bandwidth be controlled and allocated based on your operational needs? These include assigning service based on role, location, incident type, applications and devices?

AGENCY PARTITIONING

Are multiple agencies or jurisdictions able to configure their own priority profiles independent of others on a shared system?

REACTING TO INCIDENTS ON THE FLY

Once the PS LTE system has been architected to support prioritization and preemption, can we easily amend these options on the fly to react to unfolding situations?

QUALITY OF SERVICE MONITORING AND KEY PERFORMANCE INDICATORS (KPIS)

Are real-time feedback and key performance indicators provided to confirm that priority is being applied correctly?

COST-EFFICIENT DEPLOYMENT

Can the solution work with new and legacy apps?

SECURITY

Is government grade security supported? Providing fully encrypted end-to-end data sessions? Can the recommended solution be compatible with commonly used public safety Mobile Virtual Private Networks (MVPN) for end-to-end security on shared network resources?

BE IN CONTROL

Where multiple agencies are using the same network, can priority be dynamically assigned to each agency based on predefined protocols?

DEVICES

Can the solution work with any device and on any operating system?

PS LTE offers huge potential to increase the intelligence, awareness, and in-mission support tools available to your people. For this to be optimized, you must be able to assign bandwidth to them based on the assessment of the threat level, the devices they have, the applications they need, and the role they are fulfilling. With standard LTE including only limited prioritization and preemption capability, it's important to start thinking about the tools you need to match the mission critical capabilities you have now to ensure your teams always have the right service at the right time.

SOURCES
1. Seattle Seahawks: http://www.seattletimes.com/seattle-news/cell-use-at-seahawks-parade-swamped-wireless-networks/
2. Boston Marathon Bombing: http://www.cnet.com/news/cell-service-hit-in-boston-following-bombings/
3. Mid-Atlantic Earthquake: http://betanews.com/2011/08/23/virginia-earthquake-knocks-out-regions-cell-networks/

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